Research Journal of Pure Science and Technology E-ISSN 2579-0536 P-ISSN 2695-2696
Vol 7. No. 5 2024 www.iiardjournals.org Online version

Analysis of the Geospatial Pattern of Solid Waste Dumpsites in the Abuja Municipal Area Council (AMAC), FCT, Nigeria

IGWILO, S.C.[1], Bello, I.E.[2*], Magaji, J.I.[3], & Ogah, A.T.[4]
[1,2,3,4]Department of Geography, Nasarawa State University, Keffi, Nigeria
[1]Federal Ministry of Innovation, Science and Technology (FMIST), Abuja, Nigeria
[2]ISSE/AUST, NASRDA, Obasanjo Space Centre, Abuja, Nigeria
[*]*Correspondence email:* innobello@gmail.com, ibello@isse.edu.ng
DOI: 10.56201/rjpst.v7.no5.2024.pg90.97

Abstract
The search for solution to indiscriminate waste disposal sites can be effectively approached geographically using GIS Technology but, this has not been adequately done in Abuja. Thus, analysis of the geospatial pattern of solid waste dumpsites in the Abuja Municipal Area Council (AMAC) was carried out. The locations of solid waste dump sites and the pattern of the distribution were analysed. Field survey of dump sites and GIS technique was used for data collection and mapping. The locations of existing waste disposal sites were identified and geo-tagged using Global Positioning System (GPS) on a topographical map of AMAC. The geospatial pattern of dumpsites in AMAC was statistically analysed using Nearest Neighbour Analysis (Rn). Results shows that eighteen (18) waste dumpsites were identified and most of the dumpsites are illegal. Dumpsites occupied approximately 129.5 hectares of land in AMAC. The result of Nearest Neighbour Analysis Index for dumpsite in AMAC is 1.30. Thus, the distribution of solid waste dumps showed a disperse pattern. Thus, the Null Hypothesis (H_0) that "There is no significant difference in the random geospatial pattern of dumpsites in AMAC" is rejected because the waste dump sites in AMAC are dispersed and located in close proximity to roads, rivers and built-up areas. The authorities in charge of solid waste management in AMAC like the Abuja Environmental Protection Board should improve on green technology that transforms waste to wealth and reduce the volume of waste that are disposed off to enhance good health.

Keywords: *Geospatial, Pattern, Solid Waste, Dumpsites, Nearest Neighbour Analysis*

1. Introduction

Dumpsite is where waste materials are disposed, and is the oldest form of waste treatment (Asim and Chaudhry, 2021). Historically, waste dump sites have been the most common method of un-organized waste disposal and remain so in many places around the world. Most dumpsites are located within the environment of living communities. Open and uncontrolled disposal of solid waste can impact the environment negatively. The adverse effect attendant upon the indiscriminate and improper disposal of municipal solid waste is a challenge that requires urgent and collective measures to abate (Aderoju *et al,* 2014). This has sparked various research engagements and actions globally. According to Kimani (2020), solid waste dumpsites have received significant management and research attention from various fields of study in both developed and developing

nations. However, while the developed countries have improved waste management through recycling, resource recovering and sanitary land-filling; open dumping of solid waste has remained the major approach to solid waste management in developing countries (Rabiu and Al-Sheik, 2018).

Consequently, dump sites have been described as major sources of heavy metals pollution in the environment (Agbeshie, Adjei, Anokye and Banunle, 2020). Though, numerous studies that cuts across disciplines have been done on solid waste dumpsites, majorities were on the impacts (Amadi, Ameh and Jisa, 2010; Yan, Sankoh and Tran, 2013; Fasunwo and Jaiyeola, 2014). The reports on dumpsites impacts have presented it as a taboo in the face of environmental concerned individuals, government and non-government organizations globally. However, the practice of open waste dumping has persisted; especially in Africa cities like Lagos, Kano, Anambra and Abuja. The increase is due to rapid population growth, urbanization, increasing consumption pattern and poor capacity to adopt engineering landfill.

The search for solution to indiscriminate waste disposal sites has also been approached geographically (Danbuzu, Tanko, Ibrahim and Ahmed 2014; Aderoju, Salman, Anjoye , Nwadike, Jantiku, Adebowale, Fagbemiro and Agu, 2014; Adamu, 2015; Fredrick, 2016; Naibbi and Umar, 2017; Rabiu and Al-Sheik M, 2018; Paul and Israel, 2019; Geidam and Isa, 2019; Kimani, 2020; Akanbi and Adekiya, 2020; Asim and Chaudhry, 2021). However, geographic approaches (surveying and mapping) and spatial dimensions of dumpsites in Abuja are still sparse in literature despite that indiscriminate waste disposal is common in the city (Ojelade and Aregbesola, 2014; Olaide and Dias, 2020). Knowledge of the geographical dimension and the locations of dumpsites are quite important in arresting the problem of solid waste. Thus, this study bridged this gap as it mapped and analysed the spatial pattern of waste dumpsites in the Abuja Municipal Area Council (AMAC). Therefore, answers were provided for the following research questions: Where are solid waste dumps in the AMAC? And what is the pattern of dumpsite distribution in the AMAC?. Similarly, the Null hypothesis (H_0): “There is no significant difference in the random geospatial pattern of dump sites in AMAC.” This was tested at 95% significant level.

2. Review of Empirical Studies

Fredrick (2016) examined the application of Geographic Information Systems (GIS) in determining the spatial location and distribution of solid waste dump sites in Yelwa Tsakani, Bauchi State. It was reported that 72.22% of the wastes are not properly managed by Bauchi State Environmental Protection Agency (BASEPA) in the area. The study recommended the employment of integrated solid waste management system that requires geospatial information, if sustainable solid waste management in urban areas is to be achieved. Rabiu and Al-Sheik (2018) analyzed the spatial distribution of conventional solid waste disposal methods sourced from National Population Commission across Nigeria through prediction of risk prone states by using multiple regression model and visual display of spatial distribution pattern of (NEFWDM) among Nigerian states using GIS pattern analysis. They reported cluster pattern of waste disposal methods.

Danbuzu *et al*. (2014) analysed the spatial distribution of solid waste collection points using GIS approach in urban Katsina, Katsina State, Nigeria. Result shows that "there are 741 collection points in Urban Katsina, from which only 96 (12.96%) are Legal (authorized) while all the other 645 (87.04%) are Illegal (Unauthorized). The study also revealed that the amount of illegal disposal increases as you move from low to high density settlement areas, while the reverse is the case for refuse hips size". The nearest neighbor analysis shows that both the legal and the illegal collection points, are R- values of 0.67, 0.64 and 0.89 respectively. They concluded that there is clustering and randomness of the collection points' distribution. They recommended more authorized collection points in the medium population density areas.

Furthermore, Akanbi and Adekiya (2020) analysed the Trend of Spatial Pattern of Solid Waste Disposal and Health Risks Associated with it in the Rural Areas of Kuje Area Council, Nigeria. They reported weak positive relationship between spatial pattern of waste disposal and health risks. The study recommended inculcation of relevant environmental education, introduction of necessary legislation and the need for attitudinal change towards waste disposal on the part of rural populace. Naibbi and Umar (2017) appraised the spatial distribution of solid waste disposal sites in Kano Metropolis, Nigeria. They identified three hundred (300) dumpsites with clustering pattern in the centre of the metropolis than the outskirts. They also observed that about 80 percent (80%) of the sites are either located very close to roads, settlements or water bodies and about 92% dump locations are open space. The authors recommended intervention of policymakers in relocating the existing unauthorized dump sites to more suitable areas.

Asim and Chaudhry (2021) explored the spatial distribution of illegal dumpsites and their health impacts (prevalence of Diarrhoeal diseases) on the people living proximal to these sites in Makokoba Township in Bulawayo, Zimbabwe. They reported that "seventeen illegal dump sites were identified and mapped. A total of 147 individuals out of 480 (31%) had suffered from diarrhoeal diseases and 84 (57%) stayed within the 90-metre buffer zone. There was a strong correlation between proximity to dumpsite and those living within the 90metre buffer, showing a higher risk of developing diarrhoeal diseases than those staying outside the buffer zones. They recommended improvement of waste management techniques to eliminate the illegal dumpsites and reduce the prevalence rates of diarrhoeal diseases.

Geidam and Isa (2019) carried out spatial analyses of suitable solid waste dumping sites in Damaturu, Yobe State Nigeria. The results shows that "65% of the study area is unsuitable for solid waste dumping; 1.3% less suitable; 21.8% moderately suitable; and 11.9% most suitable". Fatunmibi and Gbopa (2021) examined the distribution of dump sites within the Polytechnic, Ibadan, Nigeria. They reported that "there are more illegal dump sites than legal dump sites. Based on proximity of the dump sites to the roads, waterways and built up areas, many of the dump site were very close to buildings where they only not destroy the aesthetic value of the areas but also constitute breeding grounds for vectors like flies, rodents, mosquitoes, which transmit diseases like typhoid fever, malaria, cholera and laser fever which are part of the killer diseases in Nigeria and most of the African countries". They recommended that more legal dump sites should be created and monitored in the study area, most especially in the Northern parts of the study area.

In addition, Adamu (2015) analysed the spatial distribution of dumpsites in Doka and Gabasawa Districts of Kaduna Metropolis, Nigeria. The result shows "that most of the dumpsites were situated close to the residential area and most were within the radius of 200 meters and that wastes dumped at dumpsites are mostly polythene bags, plastic bottles and plastic bottles". It further shows that there are no formal disposal dumpsites in Doka and Gabasawa. The study, therefore, recommended sensitization of the general public on the dangers associated with indiscriminate refuse disposal. Very similar to report of Adamu (2015), Paul and Israel (2019) analysed the spatial distribution of dump sites in the Federal Polytechnic, Ado - Ekiti, Nigeria. The result showed that most of the wastes generated from these dump sites are in the form of polythene bags and plastic bottles. The report also shows the legal dumpsites in the area are located within the residential land use. The study s recommended that the general public should be well sensitized on the dangers associated with indiscriminate refuse disposal.

On a general note, Aderoju, Salman, Anjoye, Nwadike, Jantiku, Adebowale, Fagbemiro and Agu (2014) used a Geo-Spatial Approach for Sustainable Development plan of Solid Waste Dumpsites in Minna, Niger State, Nigeria. The findings indicate that "there were 31 major dump sites in Minna which are situated within built-up areas mostly along major roads and watercourses. The proximity analysis based on the National Environmental Standards and Regulations Enforcement Agency (NESREA) used at distances 1000m, 500m and 250m showed that built-up areas, major roads, and watercourses fall within buffer range to dumpsites". Thus, the efficacy of using geospatial approach in waste management has been exemplified in the literature reviewed in this study. This justifies the adoption of the geospatial approach in this study.

3. Materials and Methods

Material used for the study include topographical map (1:5000 scale) of AMAC, and Global Positioning System (GPS). Field survey and GIS techniques were used for data collection. The locations of existing waste disposal sites were identified and geo-referenced using Global Positioning System (GPS) on a topographical map (1:5000 scale) of AMAC. The data were prepared and analysed using ArcMap 10.2.1 and Erdas Imagine 11 software to produce the spatial distribution maps for solid waste disposal sites within the AMAC. The sites were numbered after which the distances of closet sites were measured to calculate the geospatial pattern. The geospatial pattern of dumpsite in AMAC was determined using the Nearest Neighbour Analysis (Rn).

$$Rn=0.5 \ \mathbf{X} \ \frac{\overline{D}}{\frac{1}{\sqrt{N}/A}}$$

Where Rn = value of the nearest neighbour statistic, $\overline{D}$ = mean distance between nearest neighbours, A = total area under study and N = number of points in the map.

4. Results and Discussions

Table 1 presents the geographical locations and description of waste dump sites in AMAC. It can be deduced from table 1 that eighteen (18) waste dumpsites were identified and most of the dumpsites are illegal. Secondly, dumpsites occupy approximately 129.5 hectares of land in AMAC. The land occupied solid waste dumps can be utilized for socio-economic activities that add value to the development of AMAC if the stakeholders embrace zero waste mechanisms. The dump sites, no doubt, have environmental and socio-economic implications on the area council, hence the need to carry out extensive waste management practices towards achieving a healthy environment.

Table 1: Geographical Locations and Description of Waste Dump sites in AMAC

S/N	Dumpsite	Coordinates		Approximate Size in hectares	Status	Land Mark
		Northing	Easting			
1	Gosa	9.0 02047	7.020216	89	legal	Idu industrial layout
2	Mpape	8.798845	7.306847	16	legal	Football Field
3	Nyanya	8·84923	7.52682	2	Illegal	Karu cemetery
4	Apo	9.002023	7.473106	1.5	Illegal	-
5	Ajata	9·23453	7.56166	6.5	Legal	-
6	Apo 2	9.00134	7.47688	2	Illegal	-
7	Lugbe	8.97352	7.36752	I	Illegal	Car wash Lugbe II
8	Chika	8.993023	7.403382	I.5	Illegal	Car garage
9	Piwoyi Central	8.996953	7.38829	I	Illegal	MFM Church
10	Trade Moore Estate	8.963567	7.386918	I	Illegal	Ajuji hotel
11	Dutse	8.993023	7.403382	4.5	Illegal	-
12	Karshi	8.957015	7.368142	3	Illegal	Angwan Tiv Road
13	Guzape	8.993815	7.404528	2	Illegal	Timber shade
14	Dei-die	8.965042	7.38066	I	Illegal	Timber shade
15	Kuchigoro	9.00134	7.47688	I	Illegal	Airport road
16	Utako	8.98924	7.403012	I.5	Illegal	Canopy hotel
17	Karu Site	8.97482	7.370005	3	Illegal	-
18	Jabi	9.061701	7.418701	I	Illegal	High court

Source: Fieldwork (2024)

Furthermore, Figure 1 shows the map visualising the geographical locations of dumpsites in AMAC. The map reveals that a total of eighteen (18) waste dumps were identified and mapped in the study area. This is lower than the number of dumpsites recorded in other cities as evidence in previous study (Naibbi and Umar, 2017). Naibbi and Umar (2017) identified and mapped 300 dumpsites in Kano metropolis Nigeria. However, it is higher than what has been reported in

Zimbabwe city. Asim and Chaudhry (2021) identified and mapped seventeen (17) illegal dumpsites in Makokoba Township in Bulawayo, Zimbabwe. Figure 1 also shows that waste dumps were located in close proximity with rivers and road and that waste dump locations were dispersed within the study area. The result of Nearest Neighbour Analysis Index (ratio) for dumpsite in AMAC is 1.30. This proves that the pattern is a disperse pattern. This is because 1.30 is greater than 1(1.30 > 1). The rule for the Nearest Neighbour Analysis is that "If the Average Nearest Neighbor Ratio is < 1, the pattern exhibits clustering. If the ratio is > 1, the trend is toward dispersion and is random when =1" (Mitchell, 2005 cited in Mustapha *et al.*, 2016).Thus, the geospatial pattern of dump sites in AMAC are dispersed in nature.

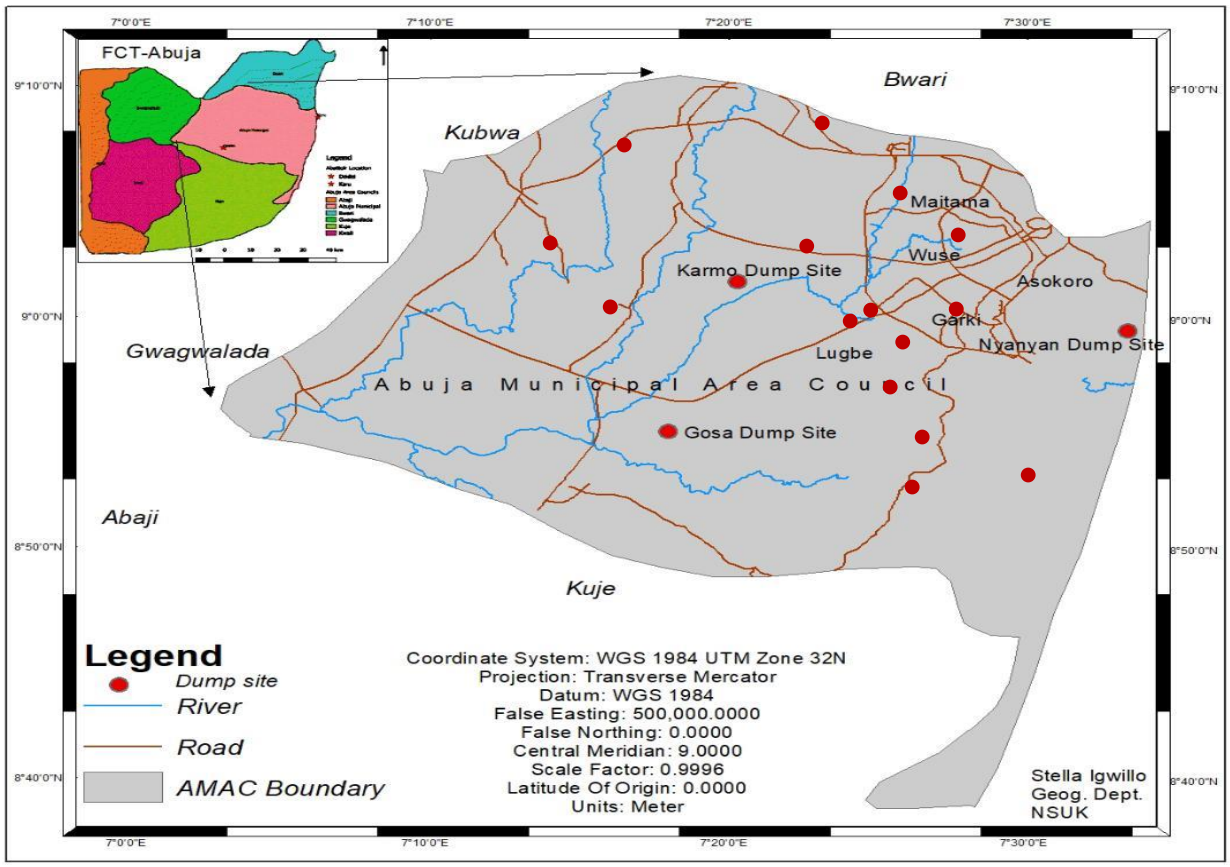

Figure 1: Geographical Locations of Dumpsites in AMAC

Thus, the H_0 that "There is no significant difference in the random geospatial pattern of dumpsites in AMAC" is rejected. Therefore, dumpsites in AMAC have a disperse pattern. Several studies have also reported disperse and random pattern of waste disposal site in Nigeria. For instance, Ojelade and Aregbesola (2014) reported random waste disposal in Nyanya, Abuja. Ajah *et al.* (2015) and Ogwuche (213) also reported indiscriminate waste disposal sites in Enugu and Bauchi states respectively. Awomeso *et al.* (2010) decried effects of dispersed dump sites in urban area in developing countries. Yoada *et al.*, (2014) reported indiscriminate waste disposal in urban Accra in the same vain, Yan *et al.* (2013) lamented scattered dumpsites in Freetown, Sierra Leone.

Wastes are commonly dumped in open dumps that usually uncontrolled within the neighborhood of residential areas in Nigeria and other developing countries (Ogwueleka, 2019).

The menace has now become an essential part of the Nigerian landscape as seen along the roadside, market places, undeveloped plots and on every street including the AMAC. Dispersed waste dumpsites have also been reported in Romania and European country (Mihai and Lămășanu, 2013). According to Mihai and Lămășanu (2013), the geographical distribution of dumpsites volumes reflects the disparities between different areas of the county, and AMAC is not left out in this regards.

5. Conclusion and Recommendations

The need to have a well structured approach in waste management formed the fucrum of this study. The study reveals that dump sites in AMAC are dispersed and located in close proximity with road, river and built up area. The authority in charge of solid waste management in AMAC like the Abuja Environmental Protection Board should improve on green technology that transforms waste to wealth and reduce the volume of waste that are disposed of. The residents should practice waste separation at home to reduce the need for disposal. The law enforcement agencies like police and civil defense should ensure that unauthorized sites are protected.

Declarations:

The authors declare that there is no conflict of interest in this study.

References

Adamu U. (2015). Spatial distribution of dumpsites in Doka and Gabasawa districts of Kaduna metropolis, Nigeria. *An Unpublished thesis* submitted to the Postgraduate School, Ahmadu Bello University, Zaria, in partial fulfillment of the requirements for the award of degree of Master of Science in Geographic Information System and Remote Sensing.

Aderoju, O.M., Salman S.K., Anjoye, S., Nwadike, B., Jantiku, J., Adebowale, R.K., Fagbemiro O.A & Agu, N. V. (2014). A Geo-Spatial Approach for Solid Waste Dumpsites for Sustainable Development in Minna, Niger State, Nigeria. *Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)*, 8(10), 16-28.

Akanbi, O.A & Adekiya, O.A.(2020). Trending Spatial Pattern of Solid Waste Disposal and Health Risks Associated with it in the Rural Areas: An Example from Kuje Area Council, Nigeria. *Annals of Geographical Studies*, 3(1), 6-12.

Amadi, A. N., Ameh, M.I. & Jisa, J. (2010). The impact of dumpsites on groundwater quality in Markurdi Metropolis, Benue State. *Natural and Applied Sciences Journal*, 11(1), 90-102.

Asim, M. & Chaudhry, M.N. (2021). Spatial dynamics of illegal dumpsites and prevalence of diarrhoeal diseases in Makokoba Township in Bulawayo, Zimbabwe. *Scientific African*, 13, 156-165.

Danbuzu, L.A. ., Tanko, A. I., Ibrahim, U.A. & Ahmed, M. (2014). Spatial Distribution of Solid Waste Collection Points Using GIS Approach In Urban Katsina, Katsina State, Nigeria. *American Journal of Engineering Research (AJER)*, 3(07), 107-116.

Fasunwo, O.O. & Jaiyeola, G.B. (2014). Impacts of Dumpsite on the Neibourhood of a Part of South- Western, Nigeria. Available online at http://www.researchgate.net /publication/265034370.

Fatunmibi, O. & Gbopa, A.O. (2021). Dump Sites Location and its Health Implications within the Polytechnic, Ibadan using Geographical Information System Approach. *International Journal of Research and Review,* 8(5), 467-478. *DOI: https://doi.org/10.52403/ijrr.20210557.*

Fredrick, V. (2016). Mapping and analysis of spatial distribution of public solid waste disposal dump sites in Unguwan Tsakani, Yelwa Tudu, Bauchi. *Unpublished* Project *submitted* to the department of Surveying and Geoinformatics Faculty of Environmental Technology Abubakar Tafawa Balewa University Bauchi in partial fulfillment of the requirement for the award of Bachelors Degree B. Tech. Surveying and Geoinformatics.

Geidam, K.K. & Isa A.M. (2019). Spatial Analyses of Suitable Solid Waste Dumping Sites in Damaturu, Yobe State Nigeria. *Asian Review of Environmental and Earth Sciences*, 6(1), 9-15.

Kimani, A. (2020). GIS mapping of community perceptions of illegal waste dumping in Mbekweni, Paarl. A thesis submitted in partial fulfillment of the requirements for the degree Master of Arts (Geography) in the Department of Geography, Tourism and Environmental Studies, University of the Western Cape.

Naibbi, A.I. & Umar, U.M. (2017). An Appraisal of Spatial Distribution of Solid Waste Disposal Sites in Kano Metropolis, Nigeria. *Journal of Geoscience and Environment Protection, 5*(11), 32-44.

Ojelade, I.A. & Aregbesola, B.G. (2014).Environmental Sustainable Development: Focusing on Solid Waste Reduction in Nyanya and, Environ of Abuja, Nigeria. *Advances in) Social Sciences Research Journal,* 1(6),123-128.

Olaide A. M. & Dias, G. A. (2020). Municipal Solid Waste Characterization as a Measure Towards Sustainable Waste Management in Abuja, Nigeria. *Journal of Environmental Science and Public Health,* 4, 43-60.

Okpara, D.A., Kharlamova, M. & Grachev V. (2021). Proliferation of household waste irregular dumpsites in Niger Delta region (Nigeria): unsustainable public health monitoring and future restitution. *Sustainable Environment Research, 31*(4):

Paul, A. J. & Israel, O.T. (2019). Spatial Distribution of Dump Sites in the Federal Polytechnic Ado - Ekiti. Nigeri*a*. *Journal of Research in Environmental and Earth Science,* 5 (1), 65-70

Rabiu, M. & Al-Sheik, M. (2018). Spatial Distribution of Solid Waste Disposal Methods, Predictions and Risk Susceptibility Using Multiple Regression Model in Nigeria. *American Journal of Geographic Information System,* 7(1), 40-47. DOI: 10.5923/j.ajgis.20180701.04.

Yan X, Sankoh FP, Tran Q (2013). Environmental and Health Impact of solid waste disposal in developing cities: A case study of Canville Brook Dumpsite, Freetown, Sierra Leone. *J. Environ. Protection,* 4, 665-670.